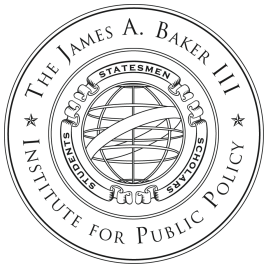

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The Texas Coast: Freshwater Inflow, Coastal Productivity, and Texas Water Policy

by

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Introduction

The Texas coast is one of the most ecologically productive and least appreciated natural assets of the United States. Unfortunately, this coastal resource is being destroyed by the various management actions (or inactions) of the state of Texas. It is not too late to reverse this destruction, but major policy shifts will be required to alter this trend.

The destruction of Texas coastal resources is a classic case of cumulative effects, which are impacts that accrue to an ecosystem by multiple actions that add impacts to each other, ultimately resulting in the loss of the entire system one small step at a time. Cumulative impact is seen in the graphic concept of "death by a thousand cuts." No one cut actually kills, but together they add up. Decades of laissez-faire attitudes about granting water rights and allowing ecological impacts have led to the loss of Nueces Bay as a viable ecologic system as well as to the death of 23 whooping cranes in winter of 2008–09. If Texas water policy is not changed in the near future, flows will be substantially reduced in the San Antonio, Guadalupe, and Colorado Rivers, and major ecological and fishery productivity damage to San Antonio, Aransas, and Matagorda Bays will occur, with Galveston Bay and Sabine Lake not far behind. On the other hand, with a bit of forethought and planning, such a fate can be avoided.

Inflows and Impacts

In the early 1970s, Corwin Johnson, a professor at University of Texas School of Law, published an article in the *Houston Law Review* that focused on the need for freshwater inflows if Texas bays and estuaries were to remain productive and alive.[1] Up until that point, water policymakers assumed that river flow that reached our bays and estuaries was "wasted water" that should be captured upstream, diverted, and put to "beneficial use."

Since that time, scientific researchers have concluded that riverine inflow is essential to a healthy bay system. However, the state has not made the adjustments in water policy necessary to insure

[1] Corwin W. Johnson, "Legal Assurances of Adequate Flows of Fresh Water into Texas Bays and Estuaries to Maintain Proper Salinity Levels," Houston Law Review 10, no. 1 (1973): 598.

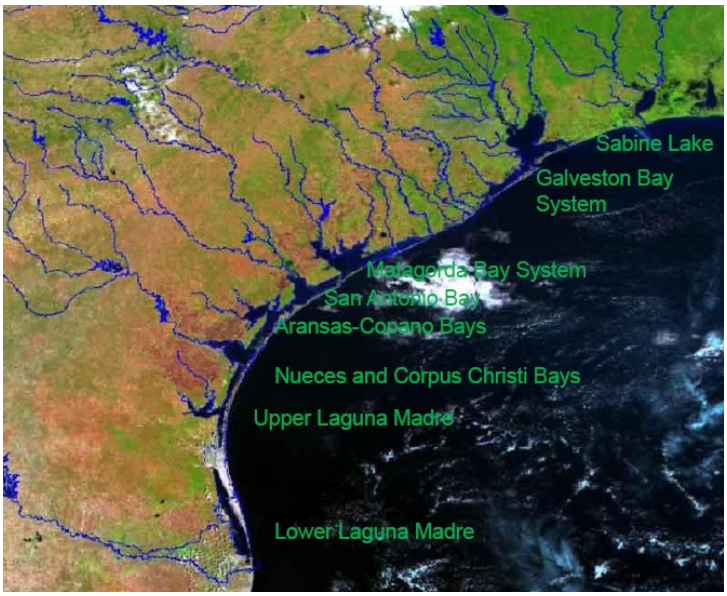
that our bays and estuaries can survive into the future. This failure threatens the ecological health and productivity of the bays, and it also creates a situation of policy turmoil that has seen several major lawsuits emerge, with more to come. Correcting this policy void will not be simple nor without political difficulties. However, the future of coastal productivity and the future growth and development of the state depends on the state getting this right.

Coastal Productivity

Our bays, with the exception of the Laguna Madre, are estuaries—areas where fresh water from riverine inflows mixes with the salt water of the Gulf of Mexico that comes into our bays through natural and man-made passes.

The Laguna Madre extends from near the Mexican border north to Corpus Christi Bay. It is noted for its high salinity, due to the absence of freshwater inflows, and has evolved to create an ecosystem adjusted to hyper-salinity. It is different than the remainder of the Texas coastal bays and estuaries, which include the Nueces and Corpus Christi Bay systems adjacent to Corpus Christi, the Aransas-Copano system near Rockport, the San Antonio Bay system southeast of Victoria, the Matagorda and Lavaca Bay systems near Port Lavaca and Bay City, the Galveston Bay system near Houston, and Galveston and Sabine Lake near Beaumont, Port Arthur, and Orange. A map showing these coastal bays and estuaries is shown in Figure 1.

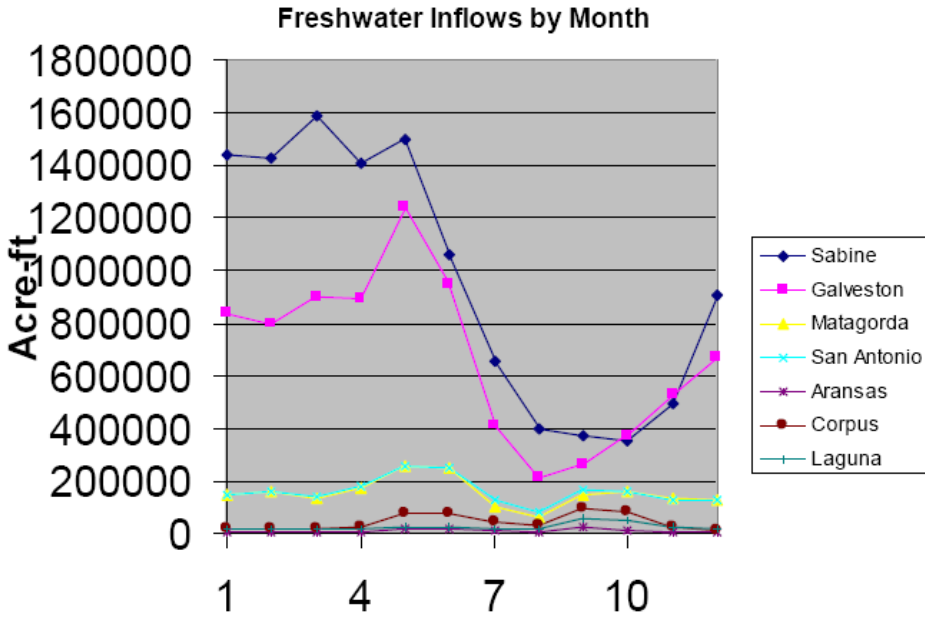
Figure 1. Bays of the Texas Coast



Source: Author

As a general proposition, riverine inflow decreases as one moves down the coast from the Sabine River to the Rio Grande. Not surprisingly, the most impacted estuary is Nueces Bay, which is the most southern estuary. A graph of inflows over the course of a year on a river-by-river basis is shown in Figure 2.

Figure 2. Monthly Freshwater Inflows for Major Texas Bays

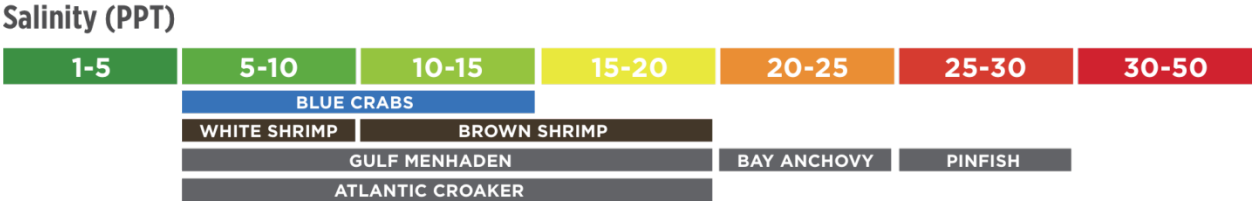


Source: Author

Estuaries are important to marine productivity in many ways. The lower salinity areas are nursery areas for all types of marine organisms due to the fact that many predator species prefer higher salinities. Additionally, certain organisms, such as oysters, seem to thrive in the middle salinity areas of the bays due to, among other things, the fact that certain oyster predators thrive with higher salinities.

All types of marine species spend at least a portion of their life cycle in the "sweeter" portions of the bay. These species include white and brown shrimp, oysters, blue crab, flounder, redfish, menhaden, and hundreds more. Without a viable estuarine system, the contribution of the Texas coast to important commercial fisheries as well as recreational fishing would no longer occur during periods of drought and perhaps more generally as is shown by Figure 3.

Figure 3. Preferred Salinity Ranges for Various Estuarine Species



Note: The Gulf of Mexico is approximately 32 PPT salinity.
Source: Texas Parks and Wildlife

From an economic standpoint, the Texas coastal estuaries support a wide-ranging economy. It is estimated that about 50% of the brown shrimp landings and about 25% of the white shrimp landings in the United States are due to the productivity of the Texas coast, a catch valued at over $450 million per year, which is added to by oysters and blue crabs. Recreational fishing is another major economic arena, generating more than $1.5 billion per year in associated expenditures.

In many respects, the economy associated with freshwater inflows has not been widely discussed or presented by fishermen and women or environmentalists, and it should be. In Houston, for example, almost any audience will listen to coastal concerns if the case for protection and preservation of the coast is made in economic terms. However, if the presentation is focused on one's ethical duty to protect important natural resources, one can easily lose the audience's attention. Similarly, if the case is made in terms of avoiding federal intervention rather than supporting such intervention, a similar result occurs.

The Loss and Degradation of Coastal Estuaries

We have tremendous natural productivity derived from the estuaries of the Texas coast. How real is the threat to coastal production? What is the risk that coastal Texas will lose these resources?

Nueces Bay

Nueces Bay is the estuary that lies just north of Corpus Christi between the Nueces River delta to the west and Corpus Christi Bay to the east. Nueces Bay is linked to the Nueces River and its tributaries, including the Frio and Atascosa. Two reservoirs have been constructed in the Nueces River watershed: Lake Corpus Christi in 1929 and Choke Canyon Reservoir in 1982.

In 2007, the Texas legislature passed Senate Bill 3, which created a process by which the environmental inflow needs of our bays were to be determined. The first step in that process was the creation of committees of scientists under the overall supervision of the Texas Commission on Environmental Quality (TCEQ) to evaluate how much is known and understood about the current status of various estuaries along the coast. These scientific study committees were called Bay and Basin Expert Science Teams (BBEST).

The BBEST report for Nueces Bay was released in January 2012 and has some startling findings. Among these are the following:

"After an extensive review and analysis of comprehensive data sets that exists for the Nueces Estuary system, the BBEST reached consensus that the Nueces Bay and Delta region is an unsound ecological environment. This conclusion was based on the substantial alterations in freshwater reaching the bay and delta which have led to a failure to sustain a healthy complement of native species and its associated beneficial physical processes."[2]

This same document also found that this impact to Nueces Bay was due to the construction and operation of Lake Corpus Christi and Choke Canyon Reservoir, the two major water supply projects serving the city of Corpus Christi and Corpus Christi industry. In the case of the demise of Nueces Bay, two specific projects and their related diversions and associated inflow reductions have been identified as the source of the problem.

These findings are astonishing. Texas water management policies caused the loss of an important estuary. Fishing is no longer excellent. Shrimpers must shrimp elsewhere. The oyster reefs are not productive. The overall ecological and economic yield of the Texas coast has been diminished.

[2] Nueces River and Corpus Christi and Baffin Bays Basin and Bay Expert Science Team, "Environmental Flows Recommendation Report," October 2011, http://www.tceq.state.tx.us/assets/public/permitting/watersupply/water_rights/eflows/20111028nuecesbbest_recommendations.pdf, 1.5–1.6.

San Antonio Bay

Nueces Bay is not alone in being impacted by the water management policies of the state of Texas. In 2013, federal Judge Janis Jack of Corpus Christi found that the commissioners of the Texas Commission on Environmental Quality and the executive director of the TCEQ had killed 23 whooping cranes by their water management actions on Guadalupe and San Antonio Rivers in violation of the federal Endangered Species Act.[3] This unprecedented federal court finding and the associated opinion and order rightly sent shock waves through the water establishment of the state of Texas. Arguably, it will never be the same again.

The problem with the whooping cranes is the same as in Nueces Bay. Water management practices of the TCEQ (and its predecessor agencies) led to severe reductions in freshwater inflows during times of drought. These reduced inflows altered the ecology of San Antonio Bay, leading to a significant reduction in the supply of blue crabs in the wintering grounds of the endangered whooping crane. Whooping cranes depend on blue crabs as their principal food supply, eating upwards of 80 crabs per crane per day.

In her written opinion, Judge Jack determined that the management actions of the TCEQ were responsible for reducing inflows and that the subsequent deaths of whooping cranes were due to the change in bay ecology and the negative impact to the blue crab population. Although Judge Jack's opinion has been overturned by the 5th US Circuit Court of Appeals on an issue of legal foreseeability under Section 9 of the Endangered Species Act and the "fairness" of holding the state liable, the fact remains that a federal judge, after an eight day trial and a full evidentiary record, made of a series of fact findings that the state's water management practices were responsible for killing whooping cranes in San Antonio Bay.[4]

The ecologic and economic situation on and around San Antonio and Aransas Bays was bad during the winter of 2008–09. Not only did 23 whooping cranes die, but it also was one of the worst fishing seasons in recent memory. The oyster fishery suffered. There were few speckled sea trout in a system renowned for its trout fishery. Real estate sales suffered in and around the

[3] The Aransas Project v. Bryan Shaw et al., 930 F.Supp.2d 716 (S.D. Tex. 2013); Jim Blackburn is also a practicing environmental lawyer and is the attorney of record for The Aransas Project in The Aransas Project v. Shaw et al.
[4] See The Aransas Project v. Bryan Shaw et al., 756 F.3d 801 (5th Cir. 2014).

Rockport area. It is not surprising that the constituency joining as members of The Aransas Project (TAP) to sue the TCEQ commissioners included commercial and recreational fishermen and women, democratic and republican political groups, Aransas County, and the city of Rockport as well as whooping crane advocacy groups and other environmentalists. This litigation was not just about protecting whooping cranes but was more generally about the economic survival of a coastal community.

Among the fact findings made by Judge Jack was the fact that the impact to San Antonio Bay and the whooping cranes was caused by hundreds of individual diverters taking some or all of their permitted amount of water. Just as in the case of the Nueces River diversions, all withdrawals were in accord with legal authorization. Essentially, the allocation of surface water from the rivers was made without concern for or appropriate consideration of the needs of the bays for freshwater inflow. Instead, human uses have usurped most of the base flow, leaving too little for the needs of the bay and coastal productivity.

Matagorda Bay

Matagorda Bay is the next bay, moving north up the Texas coast. The majority of its freshwater inflow is provided by the Colorado River, which forms the Highland Lakes, flows through Austin and down through the Lissie Prairie through Bay City to the town of Matagorda. Matagorda Bay is also at risk, due to the water management policies of the TCEQ and the river agency with authority over most of the Colorado River water rights, the Lower Colorado River Authority (LCRA). However, this water dispute is playing out differently than the two discussed above.

On the Colorado, almost all of the water use rights have been issued to the LCRA. The LCRA is the owner and operator of the Highland Lakes, which are major reservoirs north of the city of Austin that were constructed during the 1930s and 1940s. These lakes provide water supply and they also provide the setting for extensive real estate development. As part of the operation of the Highland Lakes, the LCRA prepares and submits a management plan to the TCEQ that determines how much water goes to which users—a situation that is unique among Texas rivers, where the usual situation involves hundreds of individual permits issued to different parties.

A major controversy has arisen on the Colorado River between the agricultural water users and the municipal water users in Austin and on the Highland Lakes. Among other issues are lake water levels, a hot political topic. Under the water rights system of the Colorado River, certain uses are not guaranteed but are "interruptible." The rice farmers of Colorado, Wharton, and Matagorda Counties have been cut off from irrigation water in 2012, 2013, and 2014, causing a significant reduction in rice irrigation and farming. Similarly, the bay system has seen inflows reduced and bay ecology is beginning to suffer. In many respects, the whooping crane was an indicator species for bay health in San Antonio Bay. Such an indicator species is missing in other bay systems, yet anecdotal reports about fishing success indicate that Matagorda Bay is heavily impacted at this time.

The dispute over Matagorda Bay is evolving just as the Nueces Bay and San Antonio Bay disputes have evolved. The existing permit system has allocated more water for use during times of drought than is available to meet competing demands. The bays have no water rights. When reductions need to be made, the bays and environmental flows in our rivers are the first to be affected because they essentially have no place in the water rights scheme of the state of Texas. Unless something changes, Matagorda Bay will follow the pattern.

Galveston Bay

To date, the Galveston Bay system has not been as heavily impacted as have the bays further to the south. That is due to large amounts of inflow into Galveston Bay when compared to bays further south (see Figure 2). These are the same inflows that have led to Galveston Bay being one of the most productive fisheries in the United States, with extensive commercial and recreational usage.

As with the systems further south, the Galveston Bay system is threatened by future diversions. During times of drought, wastewater discharges from Fort Worth and Dallas provide much of the flow in the Trinity River, which in turn provides the primary inflows into Galveston Bay, along with the San Jacinto River and Buffalo Bayou running through Houston. Under Texas law, wastewater can be reused without a permit if the water is taken from the "end of the pipe" at the sewage plant. Extensive wastewater reuse has been analyzed as the number one long-term

problem for Galveston Bay, along with major permits for water withdrawals for the city of Houston from Lake Livingston.

The bottom line is that as we find water reuse being relied upon for "grey" water uses (if not retreatment for potable uses), Galveston Bay will also become threatened. Luckily, that threat is a bit further into the future than is the case with the estuaries further south.

Coastal Productivity Summary

There is a direct relationship between freshwater inflows and bay productivity. Nueces and San Antonio Bays have already been heavily impacted. Matagorda Bay is threatened, and Galveston Bay and Sabine Lake will encounter similar issues in the future, although the volumes of inflows in these bay systems is an order of magnitude higher and significant inflow quantities are still reaching these bays. However, the policies of the state of Texas have damaged and will continue to damage, if not "kill," Texas coastal productivity. Under the current policies, it is just a matter of time.

Policy Issues and Implications

There is no doubt that the current policies of the state of Texas are leading to significant impacts to coastal fisheries and ecological production. It is possible that litigation under federal laws such as the Endangered Species Act, or perhaps enforcement actions by federal agencies, will be the primary mechanism for coastal protection. While many decry such unilateral legal action, in the absence of any serious response from the state, such legal action may be the only viable option for coastal protection.

However, there are alternatives that the state could undertake. None of them will be easy. All will have major long-term implications. However, the sooner the state comes to grip with their antiquated surface water use policies, the better. Prior to discussing these policy alternatives, a quick primer on Texas water law is in order.

Texas Law of Surface Water

The water in the rivers and streams of the state of Texas is owned by the state. As a general proposition, the state of Texas has issued permits for the use of water dating back to the Irrigation Act of 1889. However, prior to that time, riparian rights were recognized by the state, leading to a mixed riparian rights and appropriative rights situation until the Texas legislature consolidated the water laws through the Water Rights Adjudication Act of 1967 and converted all surface water rights into permits, with the exception of a limited domestic and livestock (D&L) water use right that is still enjoyed by landowners owning river frontage. Since the implementation of this 1967 act, all withdrawals from Texas rivers are authorized by permit with the exception of the D&L right, which remains as the only remnant riparian right.

Today, after the conversion of all prior rights—whether riparian or permitted—to permits, the concept of prior appropriation became the law in Texas, meaning that the first right issued in time has seniority over water rights issued at later dates. These permits generally allow a volume of usage at a specific location. A senior right holder downstream can make a priority call and require junior users to curtail usage so that the senior water user can obtain his or her water. Dow Chemical recently made such a priority call at Freeport relative to their water right on the Brazos River. Once a priority call is made, the impact is felt throughout a river system, as adjustments are made in withdrawals to ensure that the water makes it to the priority user.

The TCEQ maintains a water availability model (WAM) for every river system in the state. The WAM predicts base flow—available flow for allocation—based upon certain drought and rainfall assumptions. Applicants for new withdrawals are granted permits based on availability assessments from the WAM. Over the years, permits have been issued for more surface water than is available during low flow periods with the expectation that junior users will be shut down during times of drought. More recent permits clearly state that the water rights granted by the state may only be available during a certain percentage of years and only at a percentage of permitted use during times of drought.

In this manner, more water rights are issued in a given river than are available during times of drought. This is known to all water users. Legislation that became effective in 2011 gives the

TCEQ greater flexibility for determining priorities independent of the priority date. This legislation was used in response to the priority call on the Brazos River when the TCEQ decided to honor junior water rights for municipalities rather than senior agricultural water rights. Because the Brazos has no estuary, the coastal impacts of this action were minimal. However, it is certainly arguable that the system of seniority and priority water rights is beginning to crumble in light of the realities of limited water supplies and municipalities failing to develop backup water supply plans for times of drought.

As can be seen from above, little if any freshwater inflow is available for bays and estuaries during times of drought. The freshwater needs of the bays and estuaries have not been recognized or addressed through permit provisions. In the 1990s, the TCEQ rules were changed to allow for water to be allocated for bay and estuarine inflows, but this agency rule provision was specifically repealed by action of the Texas legislature in 2005. Today, unless a specific provision is made for inflows to bays and estuaries as a term and condition of another water use permit, it is very difficult to protect the bays through state-issued water use permits.

There is one major exception. Wastewater can be reused either without a permit if it is directly recycled or with a permit if the water enters the bed and bank of a river or stream. In Galveston Bay, the city of Houston conditioned a water reuse permit by specifying that 300,000 acre-feet of wastewater discharge (which they had a right to reuse) would be dedicated to Galveston Bay. More recently, the San Antonio Water System has asked that 50,000 acre-feet of wastewater discharge to which they have the rights be allowed to be conveyed to San Antonio Bay through the mechanism of a bed-and-banks permit. That bed-and-banks permit is simply the latest attempt to work through this archaic water rights system that fails to recognize the need for and importance of freshwater inflow for the bay.

On the other hand, there is no doubt that the state of Texas recognizes the need for freshwater inflows to our coastal estuaries. The Texas legislature passed Senate Bill 3 in 2007 to study the amount of water needed for instream environmental protection as well as estuarine inflow. Although a process is set up to identify inflow needs, water rights permits in existence at the time of the completion of the inflow needs studies are exempted from the reach of S.B. 3. New

permits can only be conditioned to allow a small percentage of the allocation to become dedicated to the bays and estuaries.

If Texas bays and estuaries are to be productive and healthy, new and different requirements will need to be established. There are many possible alternative ways to achieve policy change. Three will be discussed in the following sections.

Restructuring Texas Water Rights by TCEQ Action

Under Texas water law, tremendous authority is vested with the TCEQ to oversee and potentially restructure Texas water rights. All water rights that have been issued by the state are usufructory rights, meaning that they are "use" rights and do not convey ownership in the water itself. Instead, that ownership is maintained by the state with use allowed according to the terms and limits of the permits as well as being subject to the statutes and rules under which those permits were issued and administered.

There are varying degrees of action that could be taken by the TCEQ. First, there is clear authority to restructure the existing water rights regime under the current concepts of the law of prior appropriation. Rather than issue new permits for which adequate water does not exist during times of drought, the TCEQ could simply deny requested withdrawals. With regard to existing permits, many permits have never been used but exist on the books and could be cancelled for non-use. Other permits have only been partially used; these permits could be reformed to allow only the amount of water for which a use pattern has been established. These are straightforward tasks under well-established Texas water law, yet they have almost never been utilized.

Additionally, the TCEQ has been given broad authority to take action during drought conditions, which is when the needs of the bays and estuaries are most serious. Many river systems—including the San Antonio, Guadalupe, and Nueces—are overseen by a "watermaster," a TCEQ employee with legal authority and responsibility to oversee the orderly withdrawal of water from the rivers under his or her jurisdiction. The watermaster has vast discretion under the Texas Water Code, although much of this authority has never been used. Every potential withdrawal

must be allowed by the watermaster. Without specific approval from the watermaster, no withdrawal may occur. Texas Water Code Sections 11.327 and 11.3271 give the watermaster authority to take appropriate and necessary actions when there is an imminent threat to public health and safety or the environment, including protection of minimum streamflow requirements. Therefore, there is clear authority under these watermaster provisions for the TCEQ to take certain types of action.

Additionally, Section 11.503, added by the Texas legislature in 2011, gives the executive director of TCEQ even greater authority. During a drought or other water emergency, the executive director may issue an order temporarily suspending the right of any person to use that water and temporarily restricting the right of diverters to divert that water. This authority appears to be outside the requirements of law of prior appropriation, meaning that the executive director could re-order use priorities during times of drought. In fact, this authority was used on the Brazos River to re-order use priorities after the "priority call" by Dow Chemical. In that situation, farmers felt the brunt of the water shortage, even though many of their water rights were senior to uses that were allowed to continue in spite of their junior status. This situation is currently being reviewed in the court system. Such authority has never been used for bay and estuarine protection purposes.

There are two sections of the Texas Water Code that control the TCEQ's authority over water rights—Chapter 5 and Chapter 11. For the most part, TCEQ has relied on Chapter 11 in interpreting its authority to administer water rights throughout Texas. Interestingly, Chapter 5 contains numerous provisions that have not been used by TCEQ and which could become important. For example, Section 5.102 states that the TCEQ has been given the "powers to perform any acts whether specifically authorized by this code or other law or implied by this code or other law, necessary and convenient to the exercise of its jurisdiction and powers as provided by this code and other laws." It is difficult to conceive of a broader grant of authority, particularly when combined with the requirements of other acts such as the Texas Coastal Management Act, the federal Endangered Species Act, and the federal Magnuson-Stevens Fishery Management Act. Apart from direct action by third parties to enforce these laws, the TCEQ could use these acts as a basis for any number of actions to protect bays and estuaries.

The Price of Water

According to most economists, the market is the best system for allocating goods and services. However, the current cost to use water from our rivers and lakes in Texas (for municipal, agricultural, and industrial purposes) is almost nothing and completely neglects the direct monetary costs inextricably tied to the health and productivity of our bays and estuaries. In this way, our water policy is built upon a false price that needs to be corrected. If it is not, our coastal bays and estuaries may not survive.

The price of water in Texas is unrealistically low. While notable costs are often expended on necessary engineering and infrastructure for the diversion, storage, transportation, and treatment of the water taken from our rivers and lakes, the water itself is essentially a "free good," available to be claimed by a permit applicant.

Unfortunately, this water is not "free." There are costs associated with removing water from a river or lake. Our science is clear—cause and effect exists between lowered inflows and lowered finfish and shellfish production in our bays and estuaries as shown by the previous examples of Nueces and San Antonio Bays. Even though we know that there is harm caused to the estuary from our current and proposed water management practices, Texas does not quantify that loss, much less charge it to the water user. This can and should be done.

In 1997, Robert Costanza and a group of environmental economists published "The Value of the World's Ecosystem Services and Natural Capital," wherein dollar values were set for various ecosystems found on the Texas coast, including estuaries, wetlands, algal flats, and submerged sea grass.[5] This group of economists placed a dollar value on natural functions such as waste treatment and nutrient cycling, recreation, food production, and habitat usage. These are recognized natural functions that, up to that point in time, had not been valued from a dollar standpoint. These economists' estimated values ranged from about $11,000 per acre per year for estuaries to about $5,500 per acre per year for marshes.

[5] Robert Costanza, Ralph d'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg et al., "The Value of the World's Ecosystem Services and Natural Capital," *Nature* 387 (1977): 253.

In *The Book of Texas Bays*, the acreage of our many coastal ecosystems was presented on a bay-by-bay basis.[6] Using Costanza's value metrics, Sabine Lake, Galveston, Matagorda, San Antonio, Aransas, and Corpus Christi Bays together produce about $18 billion in ecosystem services each year from the estuary itself as well as associated marshes, seagrass beds, and algal flats. Over the 50-year life of a typical surface water diversion project, these bays would generate about $900 billion in natural value for all Texans according to these metrics.

Costanza's metrics for ecosystem services have been criticized for including certain services for which no one would pay money, including nutrient cycling. However, other services such as food production and recreation directly translate into income for coastal Texans. These also can be estimated.

For example, in *The Book of Texas Bays*, the San Antonio Bay shrimp fishery was determined to be worth about $30 million a year, the crab fishery about $1 million per year, oysters about $17 million a year on the half shell, and recreational fishing about $6 million (based on 500,000 man-hours at $12 per hour). Collectively, these marketable services generated about $55 million a year, a number that does not include indirect economic values. For comparison, the value of the San Antonio Bay estuary is estimated at $1.4 billion per year using Costanza's metrics.

The Texas Water Development Board, the Texas Commission on Environmental Quality, and the Texas Parks and Wildlife Department have worked together over decades to produce excellent computer models such as the Texas Circulation and Salinity Model (TxBLEND) that quantifies the relationship between freshwater inflows and changes in bay salinity. Other models, such as the Texas Estuarine Mathematical Programming Model (TxEMP), that link inflows to natural productivity have been published. It should be noted that TxEMP has been subjected to substantial criticism, and alternative models can and should be developed. However, TxEMP has been peer-reviewed and published and is the best that we have.

Given the criticism, care should be taken in the use of TxEMP, yet it is instructive to use this model for illustrative purposes. If one assumes that water in the Guadalupe and San Antonio

[6] Jim Blackburn, *The Book of Texas Bays* (College Station: Texas A&M University Press, 2004).

Basins was managed to provide inflow of 1.15 million acre-feet (the value that TPWD staff determined to be the lowest target value to fulfill the biological needs of the Guadalupe Estuary System) and if a water supply project were to remove an additional 100,000 acre-feet through diversion or impoundment, the bay inflow would fall to about 1.05 million acre-feet. According to TxEMP, the difference in natural productivity, between what would be produced by the inflow recommended by TPWD and the inflow after a new diversion, for brown and white shrimp, redfish, crabs, and oysters is about 14%. This does not include the myriad other species found in San Antonio Bay.

If one assumes that this reduction occurs once every three years, a 14% decline in the reported values for those identified species results in a projected loss of $130 million in natural productivity over the 50-year life of the proposed water project. During the same time period, the use of Costanza's metrics results in the loss of a stunning $3.3 billion.

This dollar loss in coastal productivity can then be allocated to each gallon of "new" water created by the hypothetical project. In the foregoing reservoir example, the TxEMP coastal impact analysis results in a cost increment of $1,300 per acre-foot. This cost would be added to the projected cost per acre-foot of water production from the new project, which was estimated to be about $800, leading to a net cost of over $6 per thousand gallons. For comparison, desalination currently is estimated at about $6 per thousand gallons, a cost that is clearly competitive if the "full cost" of that surface water is calculated and charged. With Costanza's metrics, the cost of water produced would rise by $33,000 per acre-foot, or about $101 dollars per thousand gallons.

This example is just that—an example. It is intended to show what can and should be done to guide future water planning. There is no doubt that we can kill a bay by depriving it of fresh water. There is also no doubt that we can develop tools to predict the incremental costs of these harms. It might take a couple of million dollars per bay system to create fully defensible models, but it can be done. The difficult issue is whether sufficient commitment exists to get the price right and send the proper market message to water consumers.

Recently, state voters approved the use of up to $2 billion by the Texas Water Development Board (TWDB) to facilitate development of new water projects. The TWDB should be commended for its willingness to consider innovative approaches for water supplies. In the same vein, the expenditure of this money should be guided by science and the market working together to insure a future that has both adequate water and productive bays and estuaries.

Legal Action by the Federal Government

There is clear authority for action by various federal agencies. Such action is often decried by Texans and Texas officials, yet it is situations such as this with the Texas bays and estuaries that provide the incentive, if not the necessity, for federal action. Without federal clean water, air, and hazardous waste initiatives, we would likely have far less environmental protection in Texas today. There are a few initiatives that are more likely than others.

Endangered Species Act

Federal enforcement action under the Endangered Species Act is a reasonable course of action to protect coastal bays. The San Antonio and Aransas Bay systems are home to the whooping crane, which was the subject of Judge Jack's 125-page opinion with extensive fact findings about the role of the TCEQ in killing whooping cranes. Although the 5th Circuit overturned Judge Jack's decision, that ruling was limited to an interpretation of the foreseeability requirement under Section 9 of the Endangered Species Act, which specifically addresses "takes" of endangered species.

On the other hand, the authority of federal agencies to address endangered species concerns is established under Section 7, which prohibits federal agencies from taking action that jeopardizes the continued existence of any species. Section 7 covers direct federal action, such as federally funded dam projects, as well as permit actions by federal agencies such as the US Army Corps of Engineers. Unlike certain laws, the Section 7 requirement is ongoing, meaning that an agency maintains a continuing responsibility to reconsider impacts to endangered species whether a project is already constructed or not. Therefore, saltwater barriers and reservoirs constructed with federal money or under federal permits must be reviewed periodically to determine their role in

the ongoing viability of the species. No such review has occurred for many of the freshwater inflow-related projects affecting the San Antonio and Aransas Bay system.

The whooping crane is not the only endangered species on the Texas coast. The endangered Kemp's ridley sea turtle frequents most Texas bays and also feeds on blue crabs, which require freshwater inflow and a healthy estuary. However, unlike the whooping crane, the Kemp's ridley sea turtle is not restricted to San Antonio and Aransas Bays, but is also found in the Matagorda and Galveston Bay systems and Sabine Lake. All existing and new federal projects must be reviewed to determine their impact on the Kemp's ridley sea turtle, and that action has not occurred relative to freshwater inflows.

Under Section 10 of the Endangered Species Act, any person may apply for a permit that allows the incidental take of an endangered species. In order to receive such a permit, the applicant must agree to prepare and implement a habitat conservation plan (HCP) identifying the steps to be taken by the applicant in an attempt to avoid a "take" of an endangered species. If the TCEQ commissioners wished to voluntarily apply for this form of protection from federal civil and potentially criminal prosecution, this avenue is open and available.

Magnuson-Stevens Fishery Conservation and Management Act

A more obscure but potentially relevant statutory provision is found in the Magnuson-Stevens Fishery Conservation and Management Act (MFCMA). The MFCMA is perhaps best known for establishing the federal requirement for regional fishery management councils and regional fishery management plans whereby optimal yields are established for the catch allowed for different species. It has been estimated that 77% of the commercially viable species spend some portion of their life cycle in coastal estuaries. This connection of habitat to productivity has been recognized in the MFCMA by the incorporation of provisions for the establishment of Essential Fish Habitat (EFH) for marine fisheries.

EFH is to be established by each regional fishery management council. In keeping with this requirement, all of the estuaries along the Texas coast have been included in the Gulf of Mexico Fisheries Management Plan. Once designated, a consultation process is required prior to

undertaking any federal action within the EFH, which is defined broadly to include the watershed within which the EFH is located. In this manner, all types of federally approved or funded activities could be subject to review for impact on EFH.

To date, this review process has not seemed to alter "business as usual" on the Texas coast. However, as issues become more focused and important, review processes can and do change. It is certainly a possible area of additional federal interest.

Conclusion

In 2000, the mouth of the Rio Grande silted over. A grand and mighty river ceased to flow into the Gulf of Mexico, dried up by the confluence of drought and water withdrawal and capture. Like the viability of the Rio Grande, the continued health and success of our bays cannot be taken for granted. We are living in a time of choices regarding the continued viability of all types of natural resources. We can choose to protect our bays and estuaries by taking a hard look at water policies, by inserting market mechanisms, and by taking the full spectrum of economic and ecologic costs and benefits into account. Or we can choose to do nothing. But either way, it is a choice.